said particle types but greater than the relaxation frequencies of at least one other of said particle types, wherein the particles having relaxation frequencies greater than or equal to the frequency of the electric field are separated from other particles.

2. The method according to claim 1, wherein the electrode is patterned by surface oxide growth, surface chemical patterning or surface profiling.

3. The method according to claim 1, wherein the particle relaxation frequency is related to the particle size, and the particles are separated based on their respective size.

4. The method according to claim 1, wherein the particle relaxation frequency is related to the surface composition of the particles, and the particles are separated based on their respective surface composition.

5. The method according to claim 1, wherein the generation of the electric field results in formation of a planar array of substantially one layer of particles in a designated area on the second electrode surface, the particles of said planar array having the relaxation frequencies greater than or equal to the frequency of the electric field.

6. The method of claim 1, wherein the second electrode is a silicon electrode coated with a dielectric layer.

7. The method of claim 1, wherein the frequency of the electric field is from about 10 Hz to 100 kHz.

8. The method of claim 1, wherein the first electrode is optically transparent and the fractionation of the particles is monitored using a video detector or camera.

9. The method of claim 1, wherein the particle mixture comprises more than two types of particles, and the particles are fractionated one particle type at a time by adjusting the frequency to allow sequential fractionation of one type of particle at a time.

10. The method of claim 1, wherein the particles are cells.

11. The method of claim 1, wherein the second electrode is a light-sensitive electrode, and the surface is illuminated with a predetermined light pattern, said illumination in combination with the electric field and the electrode patterning resulting in separation of particles.

12. The method of claim 11, wherein the predetermined light pattern is provided by an apparatus for programmably generating and imaging onto a substrate an illumination pattern having a predetermined arrangement of light and dark zones, said apparatus comprising:

an illumination source;

a reconfigurable mask composed of an array of pixels, said pixels being actively controllable and directly addressable by means of a computer-controlled circuit and computer interface, said computer-controlled circuit being operated using a software program providing temporal control of the intensity of illumination emanating from each pixel so as to form the illumination pattern comprising the predetermined arrangement of light and dark zones;

a projection system suitable for imaging the reconfigurable mask onto the substrate; and

an imaging system incorporating a camera capable of viewing said substrate with superimposed illumination pattern.

13. A method of determining the zeta potential of particles suspended in an electrolyte solution and/or the mobility of ions or molecules within a region adjacent to said particles, the method comprising:
suspending a plurality of particles at an interface between an electrolyte solution and a light-sensitive electrode;
illuminating the interface with a predetermined light pattern;
generating an electric field at the interface by application of an AC voltage, and adjusting the frequency of said electric field to produce formation of a planar array of substantially one layer of particles in a designated area on the electrode defined by the pattern of illumination;
determining the relaxation frequency of said particles;
determining the maximal velocity (vmax) of said particles; and
converting the maximal velocity and the relaxation frequency to either the zeta potential or the surface conductivity of said particles, or to both the zeta potential and the surface conductivity.

14. The method of claim 13, wherein the surface potential and the surface conductivity of the particles are determined simultaneously.

15. The method of claim 14, in which the relaxation frequency of the particles is determined by measuring the highest frequency of the electric field at which the array formation takes place.

16. The method of claim 13, in which the maximal velocity is determined by

measuring the velocities of the particles crossing impedance gradients in the course of array assembly.

17. The method of claim 13, in which the maximal velocity of the particles is determined by means of image analysis and particle tracking.

18. The method of claim 13, wherein the electrode is a silicon electrode which is coated with a dielectric layer.

19. The method of claim 13, further comprising an additional electrode, wherein the additional electrode and the light-sensitive electrode are substantially planar and parallel to one another and separated by a gap, with the electrolyte solution containing the particles being located in the gap, and wherein the electric field is generated by applying an AC voltage between the two electrodes.

20. The method of claim 13, wherein the method determines the mobility of ions or molecules within a region adjacent to the particles.

21. A method of determining the zeta potential of particles suspended within an electrolyte solution and/or the mobility of ions or molecules within a region adjacent to said particles, the method comprising:

providing a first electrode positioned in the first plane and a second electrode positioned in a second plane different from the first plane, an electrolyte solution located therebetween and a plurality of particles of one or more types, each type having a characteristic relaxation frequency, said particles being suspended at an interface between the electrolyte solution and the second electrode, wherein the second electrode is a planar electrode wherein its surface or interior having been patterned to modify the electric field at the interface;

generating an electric field between the first and the second electrode by applying an AC voltage between the two electrodes;
adjusting the frequency of said electric field to produce particle transport into a designated area of the electrode defined by said patterning of the electrode;
determining relaxation frequencies of said one or more types of particles;
determining the maximal velocities (vmax) of transport of said particles; and
determining either the zeta potential of said particles or the mobility of ions or molecules within a region adjacent to said particles, or to both the zeta potential and said mobility, based on said relaxation frequency and said maximal velocity.

22. The method of claim 21, wherein the surface potential and the surface conductivity of the particles are determined simultaneously.

23. The method of claim 21, in which the relaxation frequency of the particles is determined by measuring the frequency of the electric field at which array formation takes place.

24. The method of claim 21, further comprising the step of altering the configuration of the assembly after its formation by adjusting the frequency of the electric field, and measuring the frequency of the electric field that is associated with alteration of the array configuration.

25. The method of claim 21, in which the maximal velocity is determined by measuring the velocities of the particles crossing impedance gradients in the course of array assembly.

26. The method of claim 21, in which the maximal velocity of the particles is determined by means of image analysis and particle tracking.

27. The method of claim 22, wherein the electrode is a silicon electrode which is coated with a dielectric layer.

Respectfully submitted,

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